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ABSTRACT

This document examines electronic display units for video and computer images in education. It begins by examining the viewing conditions necessary to have quality electronic images and identifying three essential criteria for image quality: definition, contrast, and luminosity. The two types of electronic images, video and computer, are then compared in terms of the nature of the transmission signals involved and the types of interfaces used. A list of factors that the potential user needs to check before purchasing display equipment precedes technical descriptions of different types of equipment, their strengths and weaknesses, and relative costs. [It is noted that it is not currently possible to display quality computer and video images with one piece of equipment.] The equipment examined is divided into two categories: cathode tube equipment, including color television, computer color monitors, and tritube videoprojectors; and liquid crystal equipment, including liquid crystal tablets and Tri-LCD video projectors. (JLB)

INTERNATIONAL COUNCIL FOR EDUCATIONAL MEDIA
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NEW ELECTRONIC DISPLAY UNITS FOR MEDIUM SIZE AUDIENCES

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1 Viewing conditions

To have full advantage of the added value of electronic images in education, their intrinsic quality should be kept. The quality does not only depend on the performance of the machines, but also on the viewing conditions.

Some precautions - which may seem evidently - should be taken to avoid unpleasant surprises when an equipment is used for the first time. The luminosity of a projected image alone is not enough to have good quality if the screen is too absorbing, the contrast of the original image will only be maintained if the viewing system does not only consist of grey, the projection will only be of high quality if it takes place in the observation zone of the screen.

The viewing observation will in any case depend on the answer on the following questions:

* Is it possible to darken the projection room ?
* Which are the dimensions of the projection room ?
* Is it preferable to view the images on a large screen, or should the sources be multiplied ?

1.1 Image quality

The quality of an image can be determined by three essential criteria, which, apart from content, offer a minimum visual comfort :

* Definition
* Contrast
* Luminosity.

1.2 Observation zone

As long as the market does not offer large flat screens for the implementation of new technologies (large liquid cristal display) or future technologies (diode, micro tips, discharge display, ...), the collective display of electronic images is only possible by means of two mediums, a cathode ray tube or a projection screen. The choice will depend on the size of the audience, which is determined by the dimensions of the projection room, hence by the optimal observation zone.

This observation zone, more or less trapezoid, depends on two criteria : the useful observation angle and the limits of the observation distance.

2 Video images, computer images

Video images, as seen on a TV-screen, and computer images form what is called electronic images. But, contrary to what we might think when we observe both images, they belong to two totally different families, as the electronic signals needed to transmit video images and computer images have a totally different nature.

Unfortunately, there is no visualisation equipment that can indifferently operate both types of signals without interface. The interface can have rather complex functions.

It has to adapt the signals coming from the source in such a way - simple if possible - that the display system can transmit them. In this way, the image quality is maintained. Only up-market systems are however capable of making such adaptions (tritube computer video projectors). For other materials (televisions, ...) the interface has to transform, even to distort, the signals to make them transmittable, which has of course a negative effect on their quality.

2.1 Nature of the signals

If we pass from video to informatics, the nature of the electronic signals generating the images differs; the display modes differ from one field to another as well. This should be taken into account in order to guarantee the compatibility of the device with the field(s) in which the different educational applications will be used.

2.1.1 The video signal

The video signal is a signal covering both data about the content of the image itself and the control signals (horizontal and vertical synchronization, mixed or composite). It should before all meet all characteristics concerning the electric level.

2.1.2 Computer signals

Computer signals are much more diversified. According to the micro-computer from which they are generated they can either be analog, or TTL (Transistor , Transistor Logic), in other words logic, or even both at the same time (RGB analog signals, TTL synchronizing signals or vice versa) and polarized negatively or positively.

Their high impedance, on the other hand, does not allow long links between the central unit and the display system.

2.2 Interfaces

The type of interface needed will depend on the display system and by the acceptable loss of image quality, depending on the computer applications which will be used.

2.2.1 Video-computer interfacing

This type of interfacing is needed if we want direct display (Video Overlay) of the video images, such as the images from a recorder, on a part of the screen or on the full screen of a computer monitor (minimum - VGA graphic card). This interface, mainly developed and used for multimedia applications, is generally offered in the form of a card to be installed on a micro-computer (Screen Machine, VideoBlaster, ...).

2.2.2 Computer-video interfacing

This interface is necessary to display computer images on any medium other than a particular computer monitor. As above mentioned, computer signals are not compatible with video signals, which are the only ones that can be displayed on other display systems (video-projector, video monitor, TV-set, ...).

There are three types of interfacings corresponding to each transformation stage, more or less degrading the quality of the computer signals :

* RGB interface / horizontal and vertical synchronization
* RGB interface / composite synchronization
* Converting / encoding interface.

3 Different equipments

Before buying, the potential user will have to check :

* which budget he can spend and if it is not better to lease certain materials;
* if the display equipment has to be a fixed station in a specialized room or portable from one room to another;
* if the images to be displayed are video, computer or both;
* in the case of computer images, which type of computer will be needed, which will be the display standard and the quality level required according to the applications viewed (PréAO, EAO, CAO, DAO, ...).

At present, it is however not yet possible to display with one single equipment computer and quality video images. And if certain video-computer or up-market tritube video-projector editors, take up the challenge, a majority of schools will not have the means to buy such expensive materials.

All this argues in favour of compatible materials. The type of connections and computer standard are very important as well.

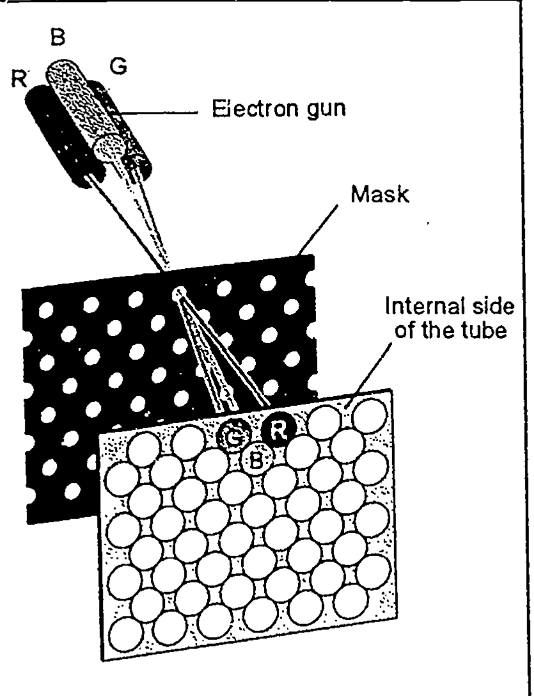
The best guarantee consists in asking the potential supplier to try out the different connections on it. Besides, this step will give an idea of the service offered by the supplier, in terms of advise and assistance.

As to the prices, always remember that schools and other educational bodies are generally given (serious) reductions.

3.1 Cathode tube equipments

The cathode colour tube first appeared on the market in 1960 and was a real technological and cultural revolution. Its appearance implied that the inevitable photographic carrier was no longer needed for the distribution of colour images : it would be replaced by the cathode tube, associated to the electronic fairy.
But how can a cathode tube scan an image, from electronic signals ?

The internal side of the tube is coated with an electro-luminescent substance, made up of triplets or vertical strips consisting of red, green and blue photophores. If this chemical substance is scanned by an electron beam, produced by the electron gun and seriously accelerated by a very high tension of about 2 400 volts, its atoms free their energy in light form (photons). The wavelength of this light, i.e. its colour, depends on the chemical nature of the photophores. The red photophores generally consist of gadolinium oxide, yttrium and europium, the green ones of zinc sulphur and cadmium, the blue ones of zinc sulphur.



Functioning principle of the cathode tube

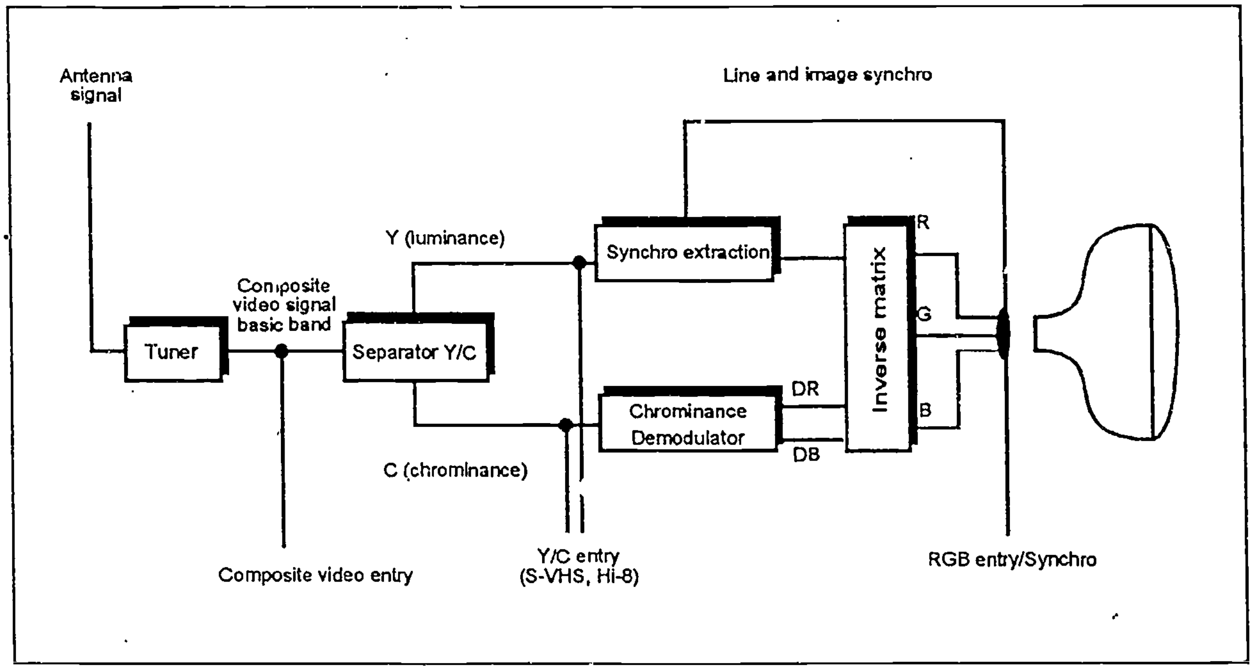
In order to obtain good discrimination of the primary colours, each strip of red, green and blue photophores will have to be intensified by three separate electron beams, respectively modulated after the composite video signal processing, by the signals related to the red, green and blue information. To make sure that each beam reaches the right strip of photophores a mask is placed between the electron gun and the screen.

3.1.1 The colour TV

The electronic signals commanding the three electron beams simultaneously correspond to the final processing phase of the video signal in a TV. As shown in the scheme, those signals are subjected to different transformations before they can be operated by the television's cathode tube.

Those transformation consists of a progressive "purification" of the initial video signal. Hence, the most complex signal to be treated, the one coming from the antenna, has to be subjected to each processing step, which will result in a loss of image quality.

If, on the contrary, the nature of the signal to be treated comes close to the nature of the signal attacking the cathode tube directly (RGB composite synchronization), the number of transformations will be limited, or inexistant, which will have no effect on the image quality.



Synoptical scheme of the processing of the video signals in a television

3.1.2 Computer colour monitor

Functioning according to the principle of a TV-monitor, a computer monitor has to have increased performances as to the mechanic and electronic pass band . This pass band has to correspond to the reproduction sensitivity of the image demanded by the informatics.

With regard to the mechanical side, the distance of the mask has to be as small as possible with regard to the dimensions of the monitor, which give it a certain fragility.

With regard to the electronic side, the pass band has to be very large (from 30 to over 100 megahertz, depending on the display standard), as the monitor should be able to display clearly each point forming a computer image of high horizontal and vertical sweep frequencies.

3.1.3 Tritube video projectors

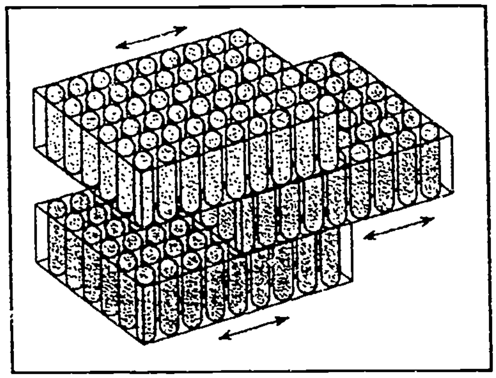
To project images, a traditional colour TV, equipped with an adequate optical device : a television projector. This system is available, but the results are of a rather poor quality.

To obtain projected images of good quality (without any geometric deformation, high-definition, etc.) and with enough luminosity, requires an extensive luminosity power on the surface of the cathode tube, hence a very strong acceleration of the scanning beam. This is only possible with a traditional colour cathode tube, as the grid of the mask needed to focus the electronic beams would be distorted by the intense and permanent influence of the electrons.

This explains why a video projector consists of three black and white cathode tubes (i.e. without mask) of small dimensions. One of the red, green or blue signals is applied to each tube, consisting of the image to visualize. Corresponding coloured optical filters are placed in front of the tubes. To obtain as much luminous intensity as possible, the electron beams sweeping the internal surface of the tubes are strongly accelerated by tension over 30 000 volts. The image obtained on each tube passes through a more or less complex optical system, to be projected on the screen. But -and this covers the difficulties of the different adjustments- the final imago being made of three separate images (a red, a green and a blue one), they have to be superimposed and converged in a perfect way. This disadvantage, in addition to the size of the device argues in favour of a fixed station tritube video projector, so that the user is not obliged to continuously make adjustments, which are very delicate so carry out correctly (focusing, convergences).

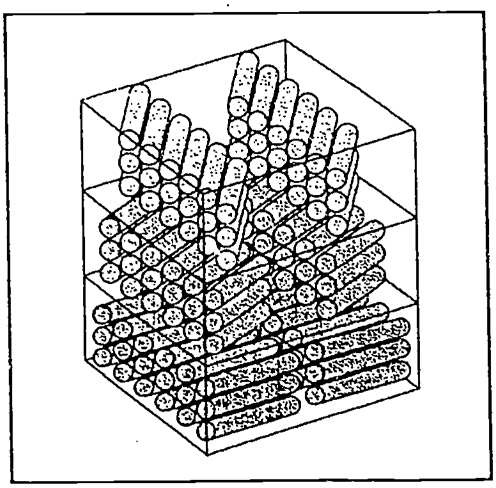
3.2 Liquid cristal equipments

The introduction on the market of a device capable to reproduce electronic images on a carrier different from a cathode tube -until now indispensable- is undoubtedly a highlight in the world of displaying. To carry out this technological revolution, we have recourse to materials which modify the luminous bias if they are frequently put in an electric field : cristal liquids.



Smectic structure

Cristal liquids are "organic liquids" of which the molecules -which have a drawn-out form - have a regular spatial structure. Situated between the eye of the observer and a luminous source, they modify the bias of the light in a privileged direction (anisotropy).



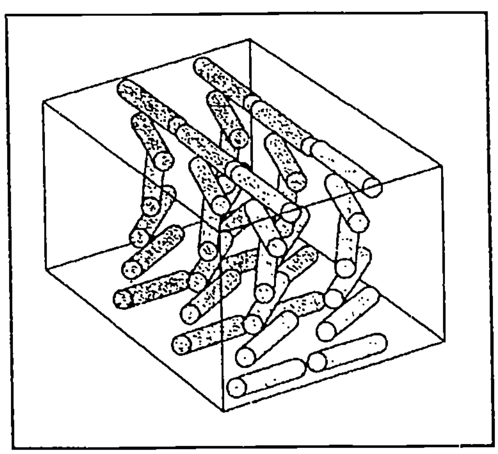
Cholesteric structure

There are three types of spatial structures :

* in a smectic structure, the molecules, organized in parallel layers, are situated perpendicularly to the axis of these layers;

* in a cholesteric structure -derived from the term cholesterol of which it has the characteristics - the molecules, in layers as well, are situated parallelly to the axis off the layers. As a result, they can rotate one to another, but this rotation is not easily controllable;

* in the nematic structure, the molecules are not placed in layers, but they are individually parallel one to another. This "piling-up" creates considerable mobility. Twisted, they can provoke the rotation of the biasing scheme of a luminous beam traversing them. The structure of this kind of molecule is called twisted nematic and used for the fabrication of liquid cristal tablet.



Twisted nematic structure

3.2.1 <u>Liquid cristal tablets</u>

An overhead projector projects a luminous beam on the tablet, which then reconstructs images from a multitude of pixels.

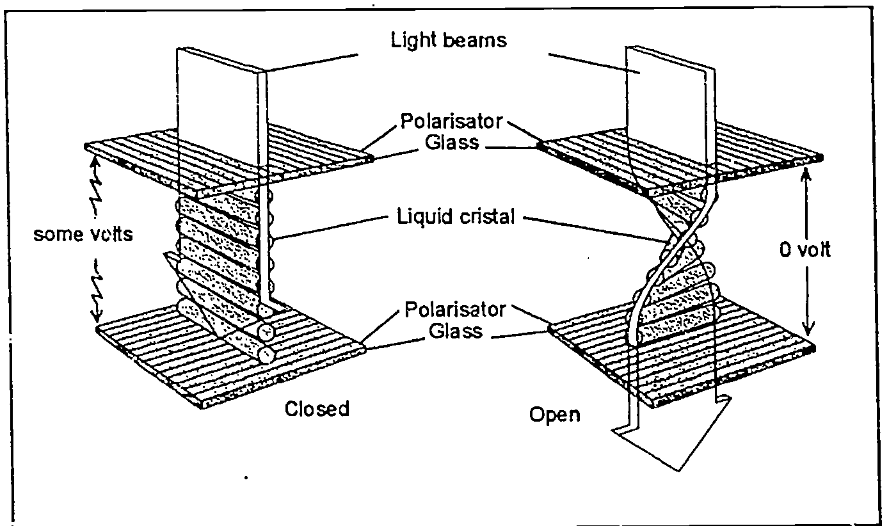
Each pixel consists of a "cell", charged with the transmittance or absorption of the light that is traversing them.

From the spiral staircase ...

Placed between two sheets of glass, optically biased according to two perpendicular axes, the molecules form a "spiral staircase", which, at rest (i.e. in the absence of an electric field), form an angle of 90°.

Hence, the light biased by the first sheet is guided by the cristal liquid, to finally escape in the biasing axis of the second sheet : the tablet is "transparent".

Conversely, if the molecules are subjected to a tension of some volts, they will be brought into one single line. The light biased by the first sheet of glass will maintain its direction and will be stopped by the second one : the tablet will be "opaque".



Functioning principle of liquid cristal tablets
(Twisted Nematic)

Each liquid cristal represents a pixel, which implies that there are needed as many as the display standard demands, in order to guarantee compatibility. A black and white LCD tablet VGA compatible will hence have to compromise minimum 307 200 liquid cristals.

... to the Triple Super Twisted

In order to find a solution for certain weak points, industrialists have done research, which has lead to the introduction of new kinds of tablets with very high capacities (different shades of grey, different colours, ...).

Today, certain cristals can carry a helicoid rotation angle above 90° (Super Twisted Nematic or STN), even up to 270° (Triple Super Twisted Nematic or TSTN). Thanks to this characteristic, the shades of grey can be largely expanded. Whereas the liquid cristals where rather "passif" at the time, the phenomenon of "lag" and "residue" is still existing. But thanks to a recent hybrid technology, called "Color Stripe" the problem has been limited.

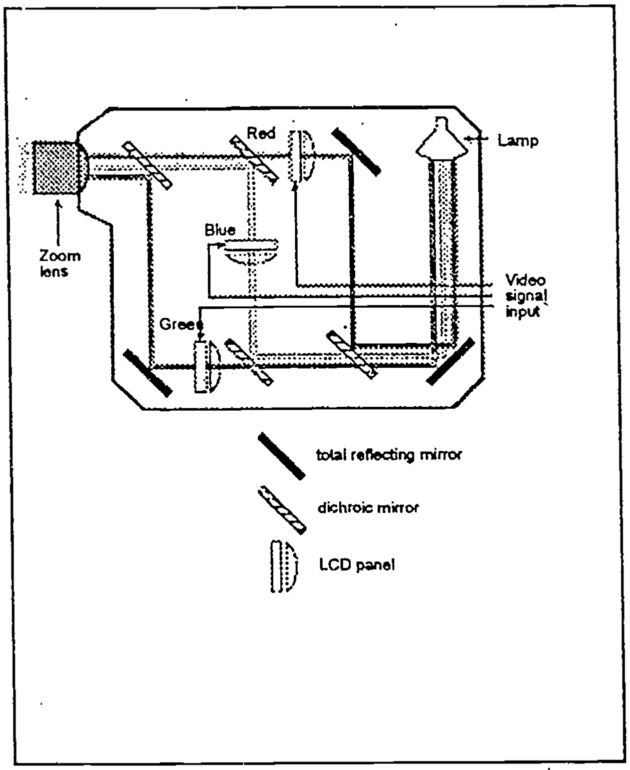
For the moment there are four important groups of tablets for overhead projection :

* Monochrome tablets
* Tablets with shades of grey or colours
* Colour tablets
* Multimedia tablets.

3.2.2 Tri-LCD video projectors

Contrary to what goes for the traditional video projector, the image is in this system no longer generated by three cathode tubes, placed optically parallelly, but -as seen on the diagram- by three small liquid cristal panels of about 7,5 cm, successively traversed by a white light beam coming from one single power. They are activated by the electronic signals corresponding to the images to be reproduced and associated to a system of dichroic mirrors.

They are charged with the transmittance of the data related to the primary colours -red, green, blue- of those images. Those cristal panels which are produced by TFT- technology, each consist of 100 000 pixels, and the newest models even of 218 000 pixels.



Scheme of the principle of a LCD video projector

As the adjustment of the convergences- or alignment of the panels- is done at the manufactory- because of the nature of the system- the size of the image and the focusing can be done by simply manipulating the lens, as a slide projector.

This simple adjusting systems makes this kind of equipment very user-friendly. Moreover, certain manufacturers offer infrared remote control, containing all these functions. As this system weighs about 10 to 15 kgs, and as it is not that large, it can be easily transported. The equipment has however to be coded down before transportation. If not, the lamp will break down prematurely (normal use : about 1 000 hours), which implies incidental expenditure.

In comparison with the equipment (between 1 000 and 2 000 US $), the lamp is rather expensive (about 100 US $).

Unfortunately, certain equipments have no integrated speaker. This limits their autonomy, hence their portability, as the audio output has to be connected to a HiFi system or to acoustic baffles.